EFFECTS OF BALD EAGLE TERRITORIALITY ON NESTING OSPREYS

JOHN C. OGDEN

Simmons (1951) defined interspecific territoriality as aggressive territorial behavior persistently performed by individuals of a species against individuals of different species. Orians and Willson (1964) and Murray (1971) summarized known examples of interspecific territoriality, particularly by nesting birds, and discussed the possible origin and functions of this behavior. Little attention has been given to documenting the effects of this behavior on nesting success of conflicting species. I studied productivity and factors affecting nesting success in Ospreys (*Pandion haliaetus*) and discovered that Osprey nesting success in my study area was affected by territorial behavior of Bald Eagles (*Haliaeetus leucocephalus*). I also noted that the interspecific relationship between the Ospreys and Bald Eagles differed in some aspects from forms of interspecific territoriality previously described. This paper describes the interspecific territoriality exhibited by Bald Eagles toward Ospreys, and quantifies the effect of this behavior on Osprey nesting success and nest-site selection.

STUDY AREA AND METHODS

Data were collected in Florida Bay, Everglades National Park, Florida. Florida Bay is a shallow estuary approximately 64 by 45 km along its longest east-west and north-south axes, and located at the extreme southern tip of peninsular Florida. The Bay contains approximately 150 small keys (islands), most of which are dominated by mangrove vegetation (Craighead 1971). It is essentially a wilderness ecosystem with little direct human disturbance, having been protected since the late 1940s by the U.S. Fish and Wildlife Service and the U.S. National Park Service. Aerial surveys during the past 10 or more years, primarily by William B. Roberston, Jr., and myself, revealed that some species of fish-eating birds (e.g., Great White Heron, *Ardea herodias occidentalis*, and Bald Eagle) have maintained dynamically stable breeding populations and may be at carrying capacity for the system. Other breeding populations have increased slowly during these years (e.g., Roseate Spoonbill, *Ajaia ajaja*, and Osprey) and may be approaching pre-exploitation numbers.

I studied Ospreys in Florida Bay between 1968 and 1974 as part of a National Park Service effort to understand population dynamics in fish-eating birds. The most intensive field work was conducted on 3 keys in the northwestern Bay (Palm, Frank, and Murray keys) where I closely followed the history of about 55 Osprey nesting sites during the 7 breeding seasons. Every active nest was visited from 1 to 6 times (nests visited 3 or fewer times were usually those that failed early) during each breeding season. I also surveyed by airplane all Osprey nests in the Bay in 1968 and 1973. The Bald Eagles in Florida Bay have been studied each year since 1960 by William B. Robertson, Jr., primarily by means of monthly aerial surveys of nests during each breeding season.

RESULTS

Each pair of Ospreys in the Bay defends only its immediate nest site from other Ospreys. Consequently several nests may be grouped, with individual nests occasionally as close together as 20 m. Most Ospreys in the Bay lay eggs in December or January, and fledge young during March or April (since the nesting season of both these raptors overlaps 2 calendar years, I refer to a particular breeding season by the second year: what I call the 1972 season actually began in late 1971). Food material collected from nests indicated that 3 species of fish, a mullet (*Mugil*), a sea catfish (*Arius*), and a jack (*Caranx*) are the prey most frequently taken by Ospreys in western Florida Bay. Bald Eagles in the Bay exhibit strong intraspecific territoriality. Generally a pair of eagles defended an area at least as large as an entire key, so that there was never more than one nest on a key. The eagles have a breeding schedule similar to Ospreys, laying eggs between late November and January, and fledging young during the spring. Eagles feed on a wide range of fish, birds, and turtles, but the 3 species of fish important to Ospreys appear to also be primary food species for eagles. In February 1973, there were 229 Osprey nests and 25 occupied Bald Eagle nests in Florida Bay.

Ospreys and Bald Eagles in the Bay are constantly in situations where interspecific territorial conflict is possible (I exclude from this discussion the interspecific conflicts where eagles harass Ospreys to steal their fish, as I saw nothing in this behavior to suggest that it related to changes in Osprey nesting). The conflicts I witnessed typically occurred when one or two eagles and one or several Ospreys were soaring over keys where both species nested, or when a perched eagle took flight from near its nest in response to a nearby soaring Osprey. I observed both species as aggressors. The aggressor usually called repeatedly and simultaneously made a shallow diving pass toward the other bird. If the attacked bird was an eagle, it usually either ignored the aggressor Osprey or performed a defensive roll in the air: if the attacked bird was an Osprey, it usually made a brief escape flight.

Eagles were persistently aggressive on keys with active eagle nests, although data presented here indicate that it probably is true that eagles only show persistent aggressiveness toward Ospreys when eagles are nesting at a new site. By contrast, Ospreys were most often observed as aggressors at sites where active Osprey nests were in close proximity to one or a pair of inactive resident eagles. Generally this occurred when an eagle on nesting territory apparently failed to acquire a mate, or a pair of eagles failed early in their nesting attempt but remained on the territory. In these situations Ospreys were not persistently aggressive. Ospreys generally ignored perched eagles, while aerial conflicts often appeared to follow chance encounters rather than

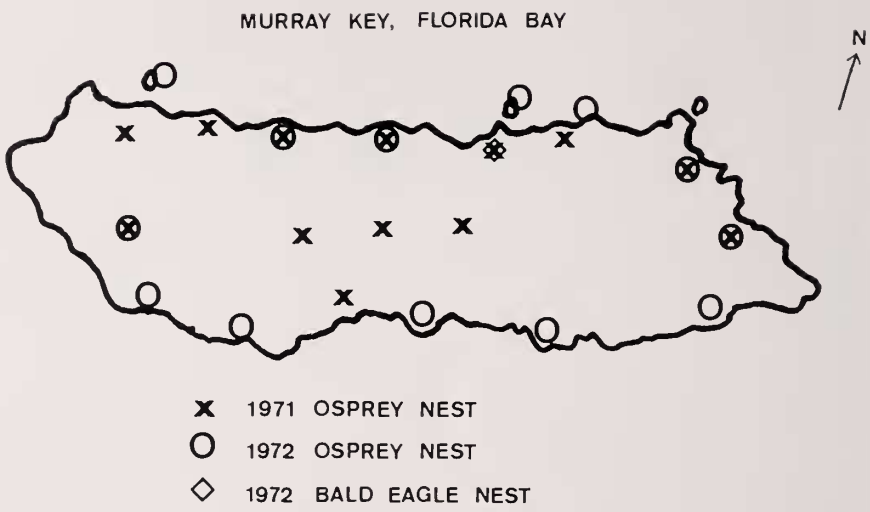

FIG. 1. Location of active Osprey and Bald Eagle nests on Murray Key, Florida Bay, in 1971 and 1972.

result from active territorial display by Ospreys. Thus only the behavior of eagles in the former situation is true interspecific territoriality.

Murray Key.—Interspecific territoriality by eagles apparently caused nearby Ospreys to relocate nests, and resulted in reduced nesting success. These effects are best seen from my observations on Murray Key. Murray is approximately 1010 m long and 375 m wide. Between 1968 and 1973, Murray supported 12 to 14 breeding pairs of Ospreys, but only 9 pairs in 1974. A pair of eagles nested on Murray for at least 11 years through 1968, then moved to nearby Oyster Keys. The eagles returned to Murray in the 1972 season, and nested successfully on the north shore in a nest used in previous years by Ospreys.

The return of these eagles to Murray Key resulted in frequent conflicts with Ospreys. One or both eagles usually were the aggressors, although the occurence of an eagle low over Osprey nests stimulated Ospreys to make occasional flying passes at the eagles. The highest frequency of interspecific activity was observed when I visited the key on 16 December, 4 January, and 19 January, when an eagle chasing an Osprey, or aerial passes by one species toward the other, generally occurred 2 to 4 times per hour throughout each day. This peak activity occurred when the eagle nest contained eggs or small young. I noted interspecific conflicts over most of the key, but primarily along the north shore. The particular attention of the eagles to the north

TABLE 1

REPEAT USE BY OSPREYS OF NESTS ON MURRAY KEY, FLORIDA BAY, 1968 THROUGH 1974

1968 nests active in 1969:	11 of 12	(91%)
1969 nests active in 1970:	12 of 14	(85%)
1970 nests active in 1971:	13 of 13	(100%)
1971 nests active in 1972:	5 of 13	(38%)
1972 nests active in 1973:	9 of 13	(69%)
1973 nests active in 1974:	9 of 12	(75%)

shore resulted in much reduced soaring and general flight activities by Ospreys there.

Correlated with the occurrence of interspecific conflict on Murray Key in 1972, Ospreys relocated 8 of 13 nests and experienced reduced nesting success. The pattern of nest relocation is shown by comparing 1971 nest sites with those for 1972 (Fig. 1). Of the 8 relocated nests, 5 were built on the south shore, away from the eagle nest on the north shore. Three Osprey nests on or near the north shore, however, remained active both years, and the 3 other relocated nests were rebuilt only short distances from the 1971 sites, and not necessarily farther from the 1972 eagle nest. Although the general direction of Osprey nest relocation was away from the eagle nest, no strong correlation exists between the pairs that moved and their closeness to the eagle nest. I do not understand why some pairs moved and others did not, because I did not quantify differences in the way individual Ospreys reacted to the eagles. The significance of 8 relocated Osprey nests in a single year is shown in Table 1, which shows nest changes for each year between 1969 and 1974. Between 69 and 100% of nests used one year were used again the next year, except in 1972 when the eagles returned and the Ospreys reused only 38% of existing nests.

The reduced nesting success on Murray in 1972, compared with preceding years and with 1974, is shown in Table 2. Ospreys experienced even poorer production in 1973, almost certainly due to a local food shortage caused by weather conditions rather than disturbance by eagles. The poor nesting in 1973 was widespread among Ospreys in northwestern Florida Bay as well as among Brown Pelicans (*Pelecanus occidentalis*) and Double-crested Cormorants (*Phalacrocorax auritus*). Reduced Osprey productivity in 1972 was not repeated in 1974, although the eagles nested on Murray in 1973 and 1974. During the 1973 and 1974 nesting seasons I did not observe territorial conflicts between the eagles and Ospreys. It appears the species adjusted to each other after 1972.

TABLE 2

OSPREY PRODUCTION ON MURRAY, PALM, AND FRANK KEYS, FLORIDA BAY, 1968–1974

	1968	1969	1970	1971	1972	1973	1974
MURRAY KEY							
Active nests[a] (total nests)[b]	11(12)	10(14)	10(13)	11(13)	11(13)	9(12)	6(9)
Successful nests[c]	5	8	6	9	3	0	5
Young fledged	10	13	12	13	4	0	7
Young per active nest	0.90	1.30	1.20	1.18	0.36	—	1.16
PALM KEY							
Active nests (total nests)	25(31)	24(27)	23(29)	25(27)	24(27)	21(28)	20(25)
Successful nests	19	12	9	12	13	1	14
Young fledged	30	20	14	19	17	2	26
Young per active nest	1.20	0.83	0.60	0.76	0.70	0.09	1.30
FRANK KEY							
Active nests (total nests)	15(15)	15(16)	14(17)	19(19)	18(24)	13(18)	12(15)
Successful nests	6	8	8	8	13	4	8
Young fledged	12	12	11	11	20	6	11
Young per active nest	0.80	0.80	0.78	0.57	1.10	0.46	0.91

[a] Nests that definitely received eggs.
[b] Total number of complete nest platforms (same as total number of pairs).
[c] Nests that definitely fledged one or more young.

If the reduced production on Murray in 1972 was eagle-caused and not due to a more widespread phenomenon, then 1972 Osprey production on nearby keys where there was no change in eagle nesting sites should have been more close to normal. This was true for Ospreys on Palm and Frank keys where production was average or above average (Table 2). The small number of young Ospreys produced on all 3 keys in 1973, referred to above, is also shown.

The 4 young Ospreys fledged on Murray in 1972 came from 3 south shore nests, among the Osprey nests farthest from the eagle nest. Although I suggest that territorial behavior by the eagles was the ultimate cause of failure of other Osprey nests on Murray, the precise way this behavior resulted in the nest failures is uncertain. I did not see direct disturbance by the eagles to the Osprey nests. Possible reasons for the nest failures, however, are revealed by a comparison of certain aspects of nesting between Murray and the 2 adjacent keys.

Reduced nesting success on Murray Key in 1972 may have been partly due to relatively late egg-laying that year. About one-half of the Frank and

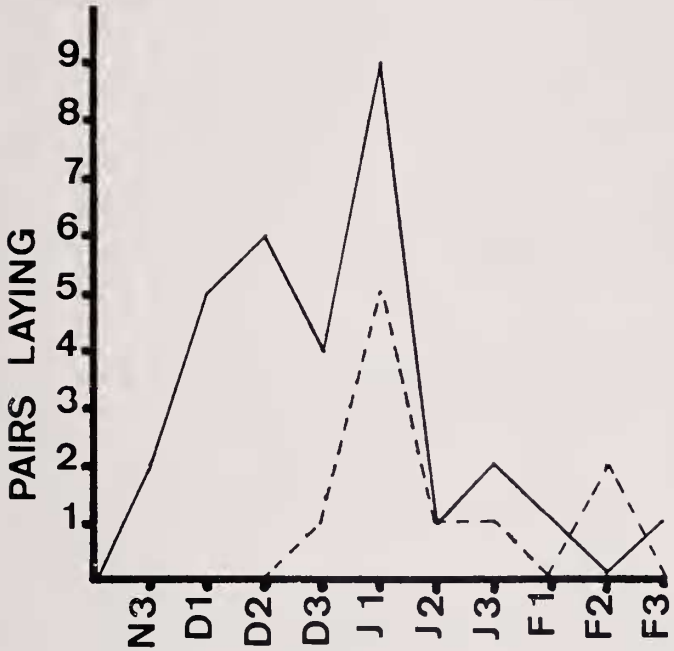

FIG. 2. Number of pairs of Ospreys laying during each one-third month on Palm and Frank keys (solid line) and on Murray Key (dash line), late November 1971 through February 1972.

Palm pairs laid prior to 1 January while only one pair on Murray laid that early (Fig. 2). Osprey eggs laid in December in Florida Bay produce more fledged young per egg than do eggs laid in January. For the years 1971 and 1972 (excluding Murray 1972). 127 December eggs produced 54 fledged young (0.42 young per egg) while 70 January eggs produced 11 fledged young (0.15 young per egg). The reduced productivity from January eggs is partly because the later eggs are more likely to be laid by less experienced, young adult Ospreys. Late eggs may produce fewer young for other reasons also, assuming December is the most favorable time biologically for laying regardless of the experience of the adults. If this is true, the relatively late laying on Murray in 1972 may partly explain the poor production that year. Eggs may have been laid late on Murray because so many nests were relocated. The one nest that received eggs prior to 1 January was a nest used the previous year, and fledged 2 of the 4 young produced in the key in 1972.

The stage at which Murray nests failed is also interesting. The number

TABLE 3

OSPREY EGG AND NESTLING LOSSES, FLORIDA BAY, 1972. COMPARED WITH LOSSES IN A MARYLAND POPULATION

Location	Eggs lost	Nestlings lost	Percent egg loss
Murray Key	8	10	44%
Frank-Palm Keys	29	4	87%
Maryland 1963–1969*	745	84	89%

* Reese 1970.

of eggs and nestlings lost from 1972 Osprey nests on the 3 keys is shown in Table 3. I believe the proportion of lost eggs to lost young on Frank and Palm is typical, as is suggested by its similarity to the losses recorded by Reese (1970) in Maryland. The high loss of nestlings on Murray is unusual although I have no certain explanation for their disappearance. It is possible that some were taken by the eagles, especially if Osprey nests were not adequately protected by overly-harassed adults. Eagles will occasionally take nestling Ospreys as was discovered in the Bay by Roberton, who collected the remains of a 5 week old Osprey from an active eagle nest on Manatee Key in 1971.

Remainder of the Bay.—If the relationship between Bald Eagles and Ospreys seen on Murray Key was representative, then similar interspecific territoriality should occur regularly in Florida Bay whenever eagles change nesting sites. To determine if this is so, I looked at the results of the 2 aerial surveys of the Bay in 1968 and 1973, to see if changes in Osprey nest sites correlated with changes in eagle nest sites. The total Osprey nests counted (excluding old, unworked, or incomplete nests) on the surveys was 203 and 229 respectively. My observations in the study area showed that individual pairs did not maintain more than one nest. A count of total nests in the Bay, therefore, provided a close approximation of the number of nesting pairs. I compared the number of Osprey nests on keys that gained, lost, or had no change in eagle nests between the surveys, and found the results consistent with the premise that eagles do influence Osprey nesting. The 6 keys that gained eagle nests showed a cumulative loss of 7 (50%) Osprey nests, while 7 keys that lost eagle nests gained 16 Osprey nests, for a 1973 total nearly 3 times the 1968 total (Table 4). No key that lost an eagle nest also had a loss in total Osprey nests, nor did any key that gained a pair of eagles also show an increase in total Ospreys. On the 6 keys where eagles displaced some Ospreys, I have no information on the timing of Osprey desertions related to arrival of eagles. No Ospreys deserted Murray in 1972, although the number of pairs appeared to have declined during the next 2 years (Table

TABLE 4

COMPARISON OF NUMBERS OF OSPREY NESTS ON FLORIDA BAY KEYS WHERE THERE WAS GAIN OR LOSS IN EAGLE NESTS (1968 VS 1973)

No eagle to yes eagle (N = 6)			Yes eagle to no eagle (N = 7)		
Location	Osprey nest counts (1968–1973)	Years eagles first nested	Location	Osprey nest counts (1968–1973)	Years eagles last nested
Butternut Keys	3–1	1969	Bottle Key	3–5	1968
Roscoe Key	3–2	1969	Bob Keys	0–5	1970
Dump Key	1–0	1970	Jim Foot Key	1–1	1970
S. Pelican Key	3–0	1971	Umbrella Key	1–2	1969
Dildo Key	3–3	1973	N. Pelican Key	2–4	1970
Catfish Key	1–1	1971	Johnson Key	1–3	1971
			Sandy Key	1–5	1971
Totals	14–7			9–25	

2). The number of Ospreys on Palm and Frank also appeared to have declined in 1973 and 1974, where there were no eagle-related reasons for Ospreys to leave. Probably no firm conclusions are possible since the lower nest counts for 1973 and 1974 could be an artifact of generally poor nesting in 1973, and the fact that I made fewer visits to these keys during the 1974 season (22 in 1972 versus 12 in 1974) and could have missed early failing nests.

Table 5 summarizes similar 1968 vs 1973 comparisons for 12 keys that had an eagle nest both years, and for 43 keys that did not have an eagle nest either survey year. Both groups included keys that gained, lost, or maintained the same number of Osprey nests. No pattern of change in Osprey nests occurred in either group, except for modest increases in total nests, reflecting the overall increase in Osprey nests between the surveys.

TABLE 5

COMPARISON OF NUMBERS OF OSPREY NESTS ON FLORIDA BAY KEYS WHERE THERE WAS NO CHANGE IN EAGLE NEST SITES (1968 VS 1973)

Yes eagle to yes eagle (N = 12)		No eagle to no eagle (N = 43)	
1968 Osprey Nests	1973 Osprey Nests	1968 Osprey Nests	1973 Osprey Nests
91	94	89	100
(3 sites no change; 6 sites increased; 3 sites decreased)		(12 sites no change; 20 sites increased; 11 sites decreased)	

DISCUSSION

Murray (1971) categorized forms of interspecific territoriality, including situations where 2 broadly sympatric species with similar habitat requirements are able to co-occupy habitat if the species exhibit different territorial systems. Murray also recognized a different relationship where 2 sympatric species with similar optimum habitats, both strongly territorial, will establish mutually exclusive territories if the species differ in size and the larger displaces the smaller. The former relationship is exemplified by Red-winged and Tricolored blackbirds, *Agelaius phoeniceus* and *A. tricolor* (Orians and Collier 1963), while the second relationship is exemplified by Red-winged and Yellow-headed blackbirds, *Xanthocephalus xanthocephalus* (Orians and Willson 1964). The relationship between Ospreys and Bald Eagles in Florida Bay seems to combine elements of both; the species have different territorial systems, and eagles are decidedly larger than Ospreys. The size difference may contribute to the eagle's dominance over Ospreys, although the fact that Ospreys maintain such small territories probably is more important in allowing the species to co-occupy habitat.

The period of intense territorial activity by eagles is time-limited at any site, apparently because of an adjustment that occurs after eagles initially nest on a key. It probably is true that the overall nesting success by Ospreys in the Bay is dependent on this time-limited characteristic. I saw no territorial behavior directed toward Ospreys by eagles on Palm and Frank keys where eagles nested without interruption during the years of my study, or on Murray Key in 1973 and 1974. And there was no important change in the numbers of Osprey nests between 1968 and 1973 on keys that had nesting eagles throughout those years. I suggest the mechanism that makes possible adjustment between these raptors is that both species exhibit site tenacity and pair fidelity; therefore the complement of Ospreys and eagles on each key is composed largely of birds that were on the same key in previous years. Presumably each pair learns to recognize surrounding pairs, and adjustments made between pairs one year carry through to succeeding years so long as the highly territorial eagles do not shift nest sites.

This paper describes how eagles adversely affect Osprey nesting in certain situations in a region where both species maintain large, healthy populations. I could not help but wonder if there are other situations where Ospreys gain some revenge. Data on Bald Eagle productivity collected by Robertson (pers. comm.) reveal considerable variability in nesting success, with some pairs having poor nesting consistently. I considered the possibility that in some way Ospreys might be responsible for low productivity by some of these eagles. Although the interactions I saw between eagles and Ospreys showed no persistent interspecific territorial behavior by the

Ospreys, it remains possible that reduced nesting success by eagles could occur where a pair is greatly out-numbered by nearby Ospreys (Palm Key had 25 active Osprey nests to 1 eagle nest in some years). Out-numbered eagles might devote an unusually large percentage of their time defending their territory so that other activities are reduced and chances of nesting failure become increased. A reexamination of my observations, however, did not reveal a clear pattern of eagles with poor nesting histories correlated with large numbers or high densities of nesting Ospreys. It seems that Ospreys in the Bay do not regularly cause specific pairs of eagles to have poor nesting, although more intense observations at certain nests might reveal exceptions.

SUMMARY

Bald Eagles in Florida Bay, Everglades National Park, exhibit interspecific territorial behavior toward Ospreys. On Murray Key, an intruder pair of eagles in 1972 resulted in relocation of nest sites by 8 of 13 pairs of Ospreys and reduction in Osprey nesting success. The conflict on Murray was not repeated in years after 1972, and Osprey nesting success improved although the pair of eagles remained. Aerial surveys of the entire Florida Bay showed an increase in numbers of Osprey nests on keys that lost a pair of eagles, and a decline in Osprey nests on keys that gained eagles. I suggest that a pair of eagles only exhibits territorial behavior toward Ospreys in the year when eagles first nest on a key, and that this behavior is not maintained in following years due to adjustments made as pairs learn to recognize adjacent pairs, a process that is possible because of the site tenacity and pair fidelity of both species.

ACKNOWLEDGMENTS

This study was undertaken while I was employed by the Office of Natural Science Studies, U.S. National Park Service. I benefited from discussions of this project with William B. Robertson, Jr., and I thank him for use of some of his Bald Eagle data and for his advice on this paper. Alexander Sprunt, IV, and Richard T. Paul also offered valuable criticisms of the manuscript.

LITERATURE CITED

Craighead, F. C., Sr. 1971. The trees of south Florida. Vol. 1. The natural environments and their succession. Univ. Miami Press, Coral Gables, Florida.

Murray, B. G., Jr. 1971. The ecological consequences of interspecific territorial behavior in birds. Ecology 52:414–423.

Orians, G. H. and G. Collier. 1963. Competition and blackbird social systems. Evolution 17:449–459.

——— and M. F. Willson. 1964. Interspecific territories of birds. Ecology 45:736–745.

Reese, J. G. 1970. Reproduction in a Chesapeake Bay Osprey population. Auk 87: 774–759.

Simmons, K. E. L. 1951. Interspecific territorialism. Ibis 93:407–413.

RESEARCH DEPT., NATIONAL AUDUBON SOCIETY, 115 INDIAN MOUND TRAIL, TAVERNIER, FL 33070. ACCEPTED 26 FEB. 1975.